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CARNIVOROUS PLANT NEWSLETTER

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CARNIVOROUS PLANT NEWSLETTER

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Front Cover: *Sarracenia alabamensis*. See article on page 43.

Back Cover: A mature plant of *Drosera neocaledonica* in the wild in southern New Caledonia. This plant is growing amongst pungent-pointed rushes on the edge of a creek. The stem is 100 mm tall. See article on page 37.

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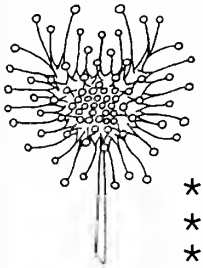

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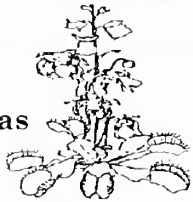

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Drosera neocaledonica: Its Origins, Habitat and Cultivation

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Keywords: observations: *Drosera neocaledonica* — cultivation: *Drosera neocaledonica*.

Introduction

The island of New Caledonia, in the south west Pacific Ocean, has a remarkable flora of over 3000 flowering plants on an area of about 18,600 km^2 . Amongst these is an endemic sundew, *Drosera neocaledonica* (Jones & Wilson, 1987). A summary of the geological history of the island group, with reference to emergent land and its profound influence on the flora, and the present conditions in which the sundew grows is presented.

New Caledonia is a French Overseas territory consisting of a number of island groups. Many are raised coral atolls, particularly the Loyalty Group, which have well-drained alkaline soils unsuitable for this sundew, and will not be discussed further here. The main island, "La Grande Terre", and associated rocky islands to the north and south have origins going back 400 million years when the basement rocks were deposited on the continental shelf of eastern Gondwana, with emergent low land of proto-Australia to the west. From 180 to 80 million years ago the bulk of the island's rocks formed between an island arc and the trench to the east, in a setting analogous to the present day Ryukyu Islands south of Japan. Between 80 and 60 million years ago the Coral and Tasman Seas opened by sea-floor spreading and extension and thinning of continental crust, moving proto-New Caledonia over 1000 km to the east, to about its present longitude. As volcanic activity around the ancestral island waned, emergent areas were maintained by block faulting; then, about 50 million years ago, a slice of young, hot oceanic crust was thrust over the island during a boundary adjustment of the Australian plate. Since then much of the oceanic crust has altered to serpentine, was deeply weathered, and then was removed by erosion, and local uplift has begun in the south as the island group begins to enter the Vanuatu Trench (Paris, 1981).

The geological history of New Caledonia has had a profound impact on the islands' flora, and goes a long way to explaining the high degree of endemism (i.e. plants and animals found nowhere else). This is essentially a relict flora from eastern Gondwana of about 70 million years ago, which has since evolved in isolation with filtered exchange with Australia and adjacent island groups. The oldest fossil land plants on New Caledonia are 180 million years old and consist of leaf fragments of extinct species of the Lauraceae, Aracauraceae, Araliaceae and Podocarpaceae; which still have species in the islands' present flora. The evolution of the islands' flora was given a further boost by the emplacement of oceanic crust composed of serpentine minerals rich in iron, magnesium, cobalt and nickel and poor in such major plant nutrients as calcium. This combination of minerals results in a soil toxic to most plants. The plants which adapted to this environment now form the remarkable sclerophyllous shrubland, or "maquis", which occurs occurs on almost all of the 6,000km^2 of oceanic crust sheet still exposed on the island (Schmid, 1987).

Figure 1: An open flower of *Drosera neocaledonica* on one of Eric Green's plants. Note the glass-like transparent styles.

Climate and Topography

The present day main island is rectangular in outline, 400 km long by 50 km wide with the long axis aligned north-west to south-east, that is parallel to the almost incessant south-east trade winds. It is a mountainous island with much land above 600 metres; the highest peaks are Mount Panie (1628m) and Mt Humboldt (1618m). Average annual rainfall is generally from 1000 mm/year to 3500 mm/year, but reaches 8000 mm/year near Mount Panie. The average monthly maximum and minimum temperatures for the capital, Noumea, are given in the following table, and may be used to estimate temperature ranges for other parts of the island using the lapse rate of approximately a 1°C temperature fall for every vertical 100 metres climbed.

	J	F	M	A	M	J	J	A	S	O	N	D
Max.	30	29	29	28	26	25	24	24	26	27	28	30
Min.	22	23	22	21	19	18	17	16	17	18	20	21

Table 1: Average minimum and maximum temperatures in degrees Celcius for Noumea (elevation 5 metres above sea level). From Logan and Cole (1997).

Absolute temperatures recorded on the island include a maximum of 35°C at Noumea and 0°C at 1000 m elevation in the centre of the island. It is not uncommon for winter minium temperatures to fall to +5 to +8°C in the islands' interior. Due to the strong trade wind influence the relative humidity stays around 75% during the year.

Plant Morphology

Drosera neocaledonica Hamet is a distinctively hairy rosetted sundew, measuring up to 60 mm across, and which ultimately forms stems to 120 mm tall (see Back Cover). The leaves are narrowly spathulate with a slender petiole commonly 20 mm long by 1 mm wide, that supports an ovate lamina 5 mm long by 2 mm wide. Both sides of the petiole have conspicuous white pilose glandless hairs; shorter appressed white hairs occur under the lamina. The scape grows up to 250 mm tall, and bears up to 20 flowers in a one-sided raceme. The scape has a weakly ascending base, with pilose white glandless hairs, however the majority of the scape has a cover of short stalked red glands.

Each flower is open for less than a day and has white, unscented petals 6 mm long. The ovary is surmounted by three colourless bifid styles which are further divided at the apex into variably divergent terete terminal segments on which the stigmatic surfaces are located (Figures 1, 2). The seed is ovoid, black, shiny, 1 mm long by 0.2 maximum diameter with reticulate vernation, and is produced by cross-pollination. Flowers have been recorded from July to December.

Habitat and Distribution

The sundew is widespread over the southern part of the island (Figure 3) and has been collected from sea-level to 1000m altitude. It grows in both peaty sand along drainage lines and around springs and also in dry-surfaced laterite gravel. Plants grow in full sun, to the shaded conditions at the base of shrubs and have even been observed growing under shallow water; the latter occurring as clonal plants on the exposed roots of plants growing on a creek bank.

Affinities

Drosera neocaledonica has a chromosome count of 2n=40, which is the same as *D. spatulata* "Kanto Form" which grows in eastern Australia (Kondo, 1976). It would appear that both sundews have a common ancestor which may have grown around 80 millions years ago, before the opening of the Tasman and Coral seas. Perhaps it is not surprising that populations of *D. spatulata* in central Queensland also share divergent divided style apices (Pearson and Pearson, 1999: page 177).

Cultivation

Surprisingly this sundew has proven tricky to grow in cultivation. Based on observations of plants in the wild and seeing plants in cultivation in Australia, South Africa and Europe, this species is adaptable to a range of soil types and grows readily in a mix of sphagnum peat and quartz sand. They grow in areas with high humidity. Whilst it is native to the tropics it is not exposed to sweltering conditions. Some higher elevation populations are exposed to temperatures of 5°C or even lower. Overall, the plant is likely to thrive in cultivation conditions which suit most highland species of *Nepenthes*. Propagation is easy from seed, which ripens from mid spring to mid summer in the wild, and the species may also be propagated by

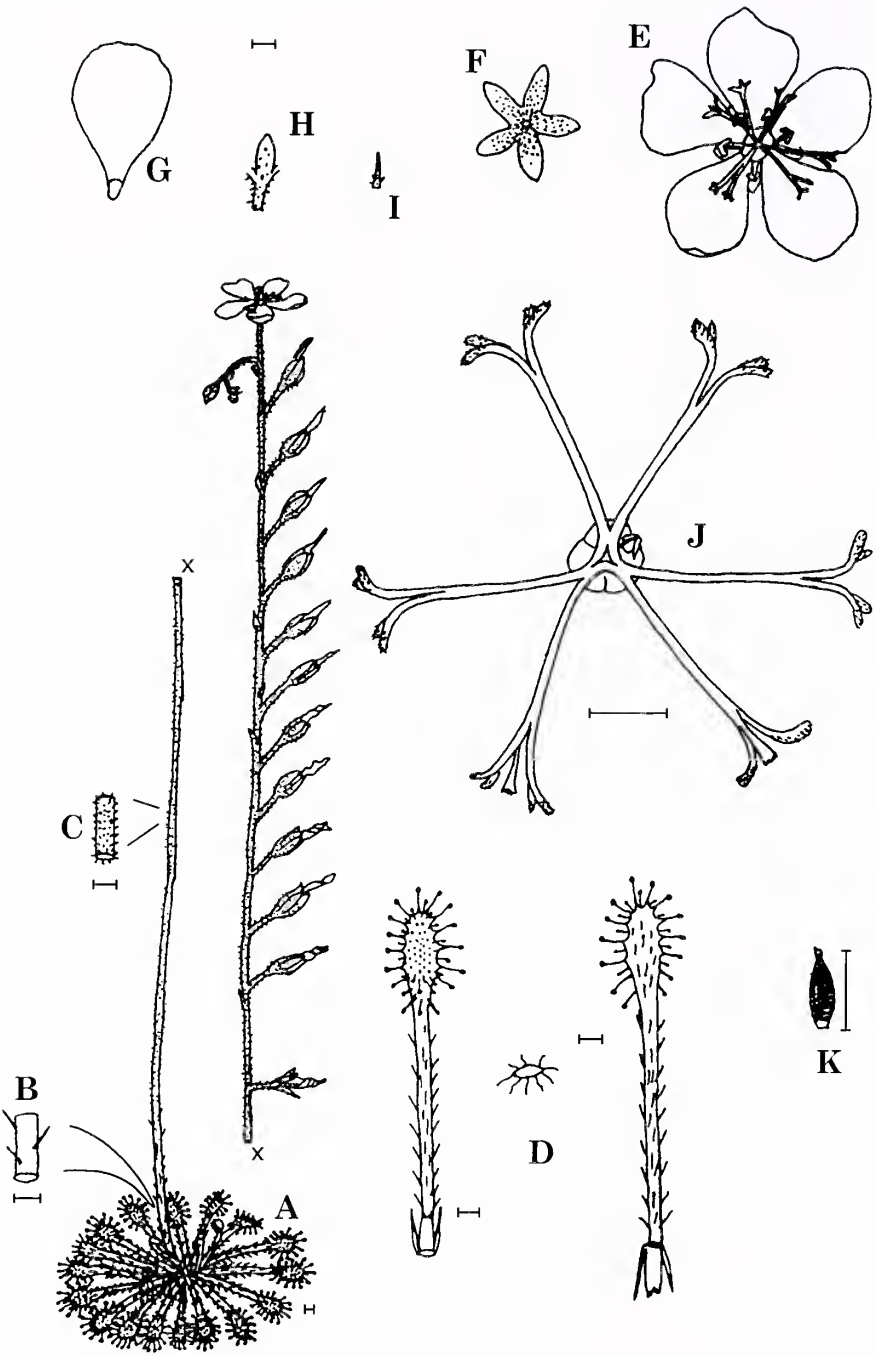

Figure 2: Botanical illustration of *Drosera neocaledonica* grown by Eric Green. A: Plant in flower; B: basal part of scape showing sparse hair cover; C: central part of scape with glandular hair cover; D: lamina; E: open flower; F: calyx; G: petal; H: sepal; I: bracteole; J: style; K: seed. Scale bar = 1 mm.

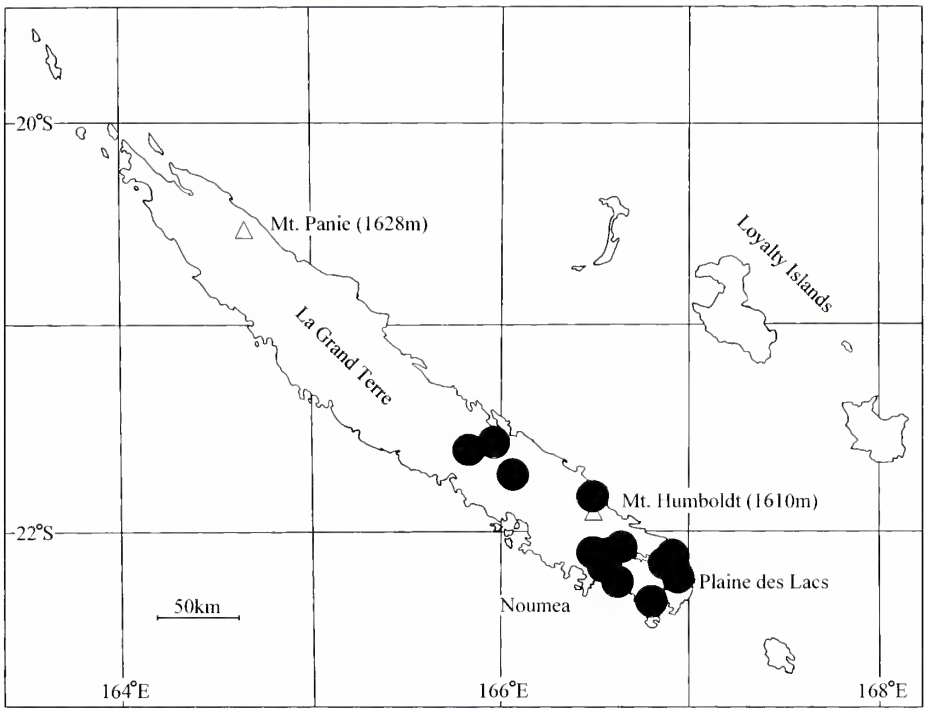

Figure 3: Sites for *Drosera neocaledonica* in the wild. Each dot denotes a location recorded on herbarium specimens I inspected, or sites I visited in my travels. The capital, Noumea, highest peaks of the island and the carnivorous plant-rich Plaine des Lacs are indicated.

leaf and root cuttings.

At least two artificial hybrids involving *D. neocaledonica* have been raised to date (*D. neocaledonica* × *aliciae*, *D. neocaledonica* × *spatulata*). The former has been grown in Japan for a number of years (e.g. Anon., 1996). The latter was recently made by myself using pollen from a pink-petalled *D. spatulata* from Jamberoo, New South Wales, Australia and one of Eric Green's *D. neocaledonica* plants. In both cases the hybrid appears more vigorous than the New Caledonian parent.

Conclusion

Drosera neocaledonica is a fascinating rosetted sundew, which is part of a rich endemic flora that has evolved in isolation on New Caledonia. The development of this species is linked to the geological history of the island. Climatic details and observations of the plant in the wild have been provided to assist in the cultivation of this sundew which has a great pedigree and history.

Acknowledgments

I wish to thank Eric Green, in Cape Town, for the opportunity to study his plants during my time in South Africa. I also wish to thank the directors and staff at the herbaria at Kew, the Natural History Museum (London), Hamburg, Lund and Berlin for granting study access to their collections. Finally I wish to thank my parents for providing the amazing opportunity to do field work on the most amaz-

parents for providing the amazing opportunity to do field work on the most amazing island of New Caledonia.

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Book Review: Food Webs and Container Habitats: the Natural History and Ecology of Phytotelmata

Reviewed by Rudolf Schmid

Kitching, R. L., 2000, Cambridge University Press, Cambridge. 431 pp., ISBN 0-521-77316-4, $100.00 (hardbound).

"Phytotelmata," a word coined in 1928 by L. Varga, refers to the localized aquatic habitats found in plant containers such as tank bromeliads, tree holes, bamboo internodes, pitchers of insectivorous plants, axils of leaves and reproductive structures (e.g., *Dipsacus sylvestris*, and especially the large tropical monocotyledons), and fallen fruits. Although this excellent work is an essential addition to the field of food-web community ecology, systematists and plant morphologists will benefit from reading the first fascinating 89 pages on the flora, fauna, and environment of phytotelmata. Most of the book (209 pages) is on the food webs created by the animal communities found in the phytotelmata; this part, although still fascinating, will appeal mainly to ecologists interested in food-web studies or to specialist botanists enchanted by their pet groups—pitcher plants, bamboos, etc. An 84-page appendix deals with the nine animal phyla found in phytotelmata. The book is very rich in detail; the 59 tables and 105 figures (chiefly graphs) not only synthesize the diverse literature (the bibliography involves 34 pages) but also present much previously unpublished information. The book has only six photographs, all of Bornean species of *Nepenthes*, and all of poor quality.

Kitching, an Australian, discusses the classic pitcher plants: *Cephalotus follicularis*, *Darlingtonia californica*, *Heliamphora* spp., and especially *Sarracenia* spp. and *Nepenthes* spp. He does not discuss the recent cases of *Brocchinia* and *Catopsis*. Pages 21-25 give general information on pitcher plants; pages 203-208 and 219-231 discuss food webs in pitchers of six species of *Nepenthes* in Borneo; elsewhere there are several dozen scattered references to various pitcher plants.

(Much of this review already appeared in Taxon, reprinted with permission—Ed.)

Rare *Sarracenia* Poaching and the ICPS

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Keywords: conservation: *Sarracenia alabamensis, S. jonesii, S. oreophila*—poaching.

Sarracenia oreophila is a rare pitcher plant that occurs in only three states: Alabama, North Carolina, and Georgia. It used to occur in Tennessee, but is now thought to be extirpated there. The species is endangered by habitat degradation and poaching. A number of private, state, and federal agencies are involved in overseeing the protection and stewardship of the remaining *S. oreophila* sites. With so many participants working towards the same goals, it is valuable for them to meet from time to time and discuss their techniques and progress. Staff of the Alabama Natural Heritage Program[SM] proposed such a meeting, and the ICPS was asked to fund it. As a board member of the ICPS I seized the opportunity and privilege to help. The ICPS fundraising drive was a remarkable success and we were able to fully fund the event (Meyers-Rice, 2000). Following the wishes from the donors, the unspent money is being donated in part to The Nature Conservancy to support further rare *Sarracenia* conservation, and the balance will be used by the ICPS for conservation projects.

In this article I will report on the meeting and what I learned about the ICPS's possible roles in future rare *Sarracenia* conservation projects. Notice I do not limit the discussion to *Sarracenia oreophila*—it would be artificial to talk about the conservation of *S. oreophila* without mentioning *S. alabamensis*, *S. jonesii*, and *S. purpurea* subsp. *venosa* var. *montana*. (This last taxon was described by Schnell & Determann (1997).) These plants are all rare, and the issues in this article are relevant to all of them.

Notes on the Meeting

The meeting was attended by staff from the US Fish and Wildlife Service; personnel from two Alabama state preserves; stewards from The Nature Conservancy programs in Alabama, North Carolina, and Georgia as well as the Alabama Natural Heritage Program[SM]; experts on biohydrology and invasive species from The Nature Conservancy; conservation staff from Atlanta Botanical Gardens; and finally (but certainly not least) several private individuals who have wild, native populations of *Sarracenia oreophila* on their property. During the two-day meeting, participants discussed their sites, shared stewardship suggestions, and even visited a few *Sarracenia* sites. My impression was that the goal of the meeting—to share information—was a success. In fact, despite the fact that all the attendees were extremely busy people, they were enthusiastic about meeting again in about two years. This is a powerful endorsement from people who would rather be working in the field than attending meetings!

I learned a few lessons of my own, but not pleasant ones. The first came long before the meeting date, when I was still raising money for it. At this time, I was surprised to hear that some of the proposed attendees were so nervous about the ICPS having anything to do with *Sarracenia* conservation that they were considering not participating in a meeting the ICPS funded. Why could this be? We wanted to help! (Fortunately, these cautious people did, ultimately, participate in the meeting.) During the meeting, I learned why they were so nervous about ICPS involvement. Nearly every attendee related horror stories about carnivorous plant enthusiasts removing plants from monitored and protected sites and generally flouting conservation laws

and ethics.

Because of widespread and persistent poaching problems, the managers attending this meeting were certainly nervous about cooperating with carnivorous plant enthusiasts. As a group, we enthusiasts have justly earned ourselves a name that will be difficult to rehabilitate. The distrust towards carnivorous plant growers (and the ICPS) is so bad that a number of times during the meeting I felt that being associated with the ICPS could be a liability to my career in conservation science!

Human Stresses on Rare *Sarracenia*

By far, the greatest threat to most *Sarracenia* species in the United States is habitat destruction. More than 90% of the *Sarracenia* habitat in the USA has been drained and converted into pine plantations, agricultural fields, ponds and lakes, golf courses, or human habitations. This is done because it is not only legal to destroy *Sarracenia* habitat—it is usually profitable, too. Even the most ambitious conservation programs could be characterized as strategies designed to save the largest possible number of remnant wetland habitats. It is as if a pie had been so voraciously cut apart and consumed that only the crumbs remained to remind us of what was once present.

In contrast with the other pitcher plant species, *Sarracenia alabamensis*, *S. jonesii*, and *S. oreophila* are in a very different situation. These species are protected by the Endangered Species Act of 1973, and are also listed on Appendix I of CITES (Convention for International Trade of Endangered Species), i.e. the most protected listing. As such, state, federal, and international laws are in place to protect the plants. This means that every population on public land is protected from habitat destruction. Furthermore, the majority of the sites on private land are protected from destruction by voluntary agreement with the landowners.

The single greatest threat to these three rare pitcher plant species is poaching!

At first, I could not believe that poaching activity was significant. As an editor of Carnivorous Plant Newsletter, I have many sources of information regarding what is happening in the carnivorous plant community—I keep an eye on nursery activity and internet sales; to see rare pitcher plants being sold is uncommon, so I did not think people were poaching them. But again and again during the *S. oreophila* meeting, I listened as managers recounted tale after tale of trespassing and theft.

For example, we all know of a preserve that contains a population of unique, anthocyanin-free *Sarracenia jonesii*. Unfortunately, this site is too well known—poachers have been so ravenous and persistent that the anthocyanin-free form of *Sarracenia jonesii* has been completely poached from the preserve. It is now extinct in the wild, because of the activities of members in our hobbyist community. Furthermore, even the normal, red-flowered plants are being poached—for three consecutive years, every seed pod has been stolen from the site, so no seedling reproduction is possible.

In another case involving *Sarracenia jonesii*, a new site for this plant was recently discovered (this brought the total number of sites to 11). It was a good site with several hundred plants. Somehow news of this discovery was leaked. Within one year, every plant had been removed. Nothing remains but shovel holes.

Even as I prepared the final draft of this paper for Carnivorous Plant Newsletter, I received word of yet another pitcher plant site that had been heavily poached. In spite of being on gated, guarded, private land, this site has been poached down to nine remaining plants.

While not every person had such dramatic stories to tell, they all had some poaching tales. At every site we discussed, whether it was for *S. oreophila, S. alabamensis*, or *S. jonesii*, plants were being stolen. Sometimes only a few plants or seedpods were stolen; sometimes whole clumps were dug out. Sometimes entire populations were removed. Poachers came on foot, by car, by truck. Some had lookouts; some came alone. Some poachers were caught; others got away.

I cannot exaggerate how disheartening it was to hear these stories and to learn about how extensive poaching is. Problem people were discussed; names were named. Some of these names were familiar to me.

What is Being Done to Help *Sarracenia*

Stewardship of *Sarracenia* sites is not easy. First, it is important that the hydrology (i.e. water quality and flow to the site) is intact. Pollutants such as pesticides, herbicides, and fertilizers can leach through the groundwater into preserves. Such compounds flowing into bogs can kill the *Sphagnum* layer, which severely disrupts the structure of the bog habitat. Even airborne pollutants can increase the nutrient levels at otherwise unthreatened sites. Stimulated into growth by these nutrients, noncarnivorous plants rapidly displace the carnivores. (This effect is particularly relevant for *Sarracenia jonesii* and *S. purpurea* subsp. *venosa* var. *montana*.) Second, prescribed fire is necessary to maintain the open and sunny structure of *Sarracenia alabamensis* and *Sarracenia oreophila* sites. Shrubs and trees can crowd out these species if wildfires are excluded for just several years. A prescribed fire program requires careful planning, timing, and highly trained personnel. If fire is an untenable solution, cutting down pioneering trees and judiciously applying herbicides may be an acceptable alternative. *Acer rubrum* and *Liquidambar styraciflua* are particularly invasive native trees. Non-native invaders, such as *Microstegium vimineum* (Japanese stilt grass) and *Ligustrum sinense* (privet), are additional threats.

Apart from the sweaty labor are a number of thorny philosophical problems. At what point does maintaining a *Sarracenia* bog translate to gardening? Is it appropriate to spend such great efforts to try and maintain "postage-stamp" sized preserves when wildland conservation in the USA is focusing more on large, landscape scale efforts? Since so many *Sarracenia* bogs have been destroyed, are the few remaining sites so separated from each other that pollination can no longer occur in a natural way, i.e. has range fragmentation already made the rare *Sarracenia* functionally extinct from an evolutionary perspective? These complex issues are more than just sources of armchair speculation—they guide stewardship decisions!

Reintroduction is also an extremely complex issue. As an important member of the conservation team, Atlanta Botanical Gardens has collected seed and is growing plants from nearly all the rare *Sarracenia* sites. If nothing else, this is an important safeguard to protect a site from complete genetic extinction if something catastrophic were to happen to it. But should plants germinated and grown at Atlanta Botanical Gardens be replanted to the wild? Of course, this would be done carefully, i.e. only seedlings originating from a specific site could be reintroduced to that specific site. But even so, would this be introducing genetic drift to the population because plants best suited for surviving for a few years in cultivation were being planted back to the wild? Equally complex is the notion of establishing new populations at either new sites, or at sites that historically had rare pitcher plants. What genetic stock should be used at the new sites? Could (or should) the new sites be allowed to cross pollinate with extant sites?

These complex questions do not have simple answers. Great damage has been done to *Sarracenia* populations, and it is important we do not exacerbate the problem with ill-constructed triage.

Finally, survey work is an important aspect of conservation. We believe that surveys have detected most of the sites where the rare *Sarracenia* species still occur, although new ones are occasionally discovered. (There are approximately 13, 10, and 23 known sites for *S. alabamensis*, *S. jonesii*, and *S. oreophila*, respectively.) All these locations[1] are under some form of management. (Certainly, all the sites on public land or land owned by The Nature Conservancy is being managed.) For some sites, this may

[1]Monitoring and/or stewardship agreements are not in place for a few fiercely guarded privately owned sites, however.

simply mean the populations are being monitored. At other sites, various forms of habitat manipulation are being done. There is evidence that a few more sites may exist, but they have not yet been found. If any new sites are found, they are likely to be small, with only a few dozen plants. However, when an overgrown site is cleared, amazing things can happen. It appears that after being overgrown by trees, *S. oreophila* may persist in a depauperate state for decades, awaiting a forest fire or some other natural disturbance to open the canopy (C. Emanuel, private communication).

How the ICPS Can Harm or Help Rare *Sarracenia*

In order for the ICPS to continue to help in *Sarracenia* conservation, trust must be established with the various management organizations already working at *Sarracenia* sites. There have been so many poaching abuses by collectors that anyone interested in visiting *Sarracenia* sites—hobbyists, scientists, or earnest ICPS members—are immediately distrusted. While the ICPS may want to help, it must demonstrate that its help can be trusted!

Since the ICPS is not financially able to purchase *Sarracenia* property, its help must be in other ways. I see the ICPS could help most in three main fields: Education, funding projects, and refining ICPS policy.

Education: Obviously, the ICPS is in an ideal position to communicate with carnivorous plant hobbyists and scientists around the world. By communicating with its membership through Carnivorous Plant Newsletter, the ICPS web site, and the carnivorous plant listserve, a very large portion of those people interested in carnivorous plants can be educated about conservation issues. We must ensure that growers are aware that these rare *Sarracenia* sites are protected, both in a conservation sense and in a legal one. From the conservation standpoint, all the sites are being monitored and stewarded[1]. Regarding the law, explorers of carnivorous plant sites should know that they cannot assume it is legal for them to wander through rare pitcher plant sites without first obtaining permission from the land owners! Every square cm of the USA is owned by some person or is overseen by some governmental agency. Visitation without first contacting landowners may result in trespassing and personal theft charges. (And beware, many landowners have firearms, and encounters can become very frightening, very quickly.) Anyone caught collecting rare *Sarracenia* on public lands can be subject to a combination of state and federal charges, including the violation of the federal Endangered Species Act of 1973. (This applies to removal of plants, seedlings, and seed.)

Fundraising: The stewardship programs at some carnivorous plant sites are not as rigorous as they could be. This reflects the reality of funding. If you are interested in helping rare *Sarracenia* conservation, contact the ICPS and make a donation to our conservation program.

Refining ICPS policy: The ICPS is planning to work with officials from the US Fish & Wildlife Service to determine how we can legally distribute seed or perhaps even plants of rare *Sarracenia*. Our hope is to help destroy the economic incentive for poaching plants by making rare *Sarracenia* easily available in an inexpensive way. We are trying to devise ways of labeling plants with location codes (i.e. AL-OR-05 for site #05 of *S. oreophila* in Alabama). Such codes would satisfy the interests of collectors who want to have plants from as many places as possible, but would not reveal geographical data to potential poachers. Until we can devise an approach that is satisfactory to the ICPS and the US Fish & Wildlife Service, the ICPS has stopped distributing rare *Sarracenia* seed through its seed bank. Furthermore, the ICPS has informed stewards of rare carnivorous plant sites that any visitors who claim to represent the ICPS in any way are not, in fact, empowered to do so. (There are some poachers who

[1]Monitoring and/or stewardship agreements are not in place for a few fiercely guarded privately owned sites, however.

claim to be visiting sites in the name of the ICPS.) Finally, it has become editorial policy of the ICPS to not include detailed geographic information as to locations of rare carnivorous plants—this applies to all ICPS publications, including the web site. This is unfortunate, since many of us like to visit carnivorous plants in the field, but we must remember that the welfare and survival of the plants override our own interests in seeing them.

How You Can Harm or Help Rare *Sarracenia*

You, as a member of the ICPS, can certainly help in the protection of rare *Sarracenia*. Obviously, never trespass, never field collect, never buy plants from poachers. Instead, support conservation programs of the ICPS and other organizations. Do not sell rare *Sarracenia* (i.e. *S. alabamensis*, *S. jonesii*, *S. oreophila*) unless you have appropriate permits (i.e. state permits as well as federal permits from the US Fish & Wildlife Service for sales within the USA, and CITES permits for international sales; if you do not live within the USA, your country may have other regulations by which you must abide). If you post information about your sales on the internet, be fastidious in following all laws—fairly or not, when individuals advertise their sales of rare *Sarracenia* on the carnivorous plant listserve, government officials equate this with the ICPS being involved. Be responsible in your horticultural practices.

If you happen to visit any suitable habitat, whether there are carnivorous plants already living there or not, never introduce or reintroduce seeds or plants you produced in cultivation. Greenhouse grown plants may be carrying diseases or non-native weeds with them; "pure" seeds may be hybrids created by a wayward pollinator acting without your knowledge. Your unmonitored additions would also confuse the scientists and landowners working to improve the wild populations of plants.

Finally, I know that many members of the ICPS are indefatigable field explorers, and have singlemindedly scoured the southeastern USA with the goal of finding as many carnivorous plant sites as possible. It is quite possible that such field researchers have found rare pitcher plant sites that have eluded the US Fish & Wildlife Service and state Natural Heritage Programs. Such sites, if they exist, would be greatly at risk since they would be unprotected by the appropriate state and federal agencies. If you know of sites that house *Sarracenia alabamensis*, *S. jonesii*, or *S. oreophila*, you should contact the US Fish & Wildlife Service or the appropriate state's Natural Heritage Program and provide as much data as you possibly can. I can provide you with appropriate contact information. These programs will only share location information with appropriate conservation officials, so do not contact them because you want to learn of sites to visit! (It has unfortunately been discovered, in lessons very damaging to *Sarracenia* populations, that this kind of information must be safe-guarded.)

Concluding Thoughts

The greatest danger to these plants is us—the very enthusiasts who should be the most interested in their well-being. Past violations by members of the carnivorous plant enthusiast community have earned us distrust, and have alienated those stewards and policy makers who should be our allies. We must proceed more carefully in the future if we wish to have any say in the protection of these marvelous plants.

I am very happy that the ICPS was able to support an event that was useful to the long-term survival of *S. oreophila*. I have been working with the other board members of the ICPS on conservation initiatives, and I think that we can look forward to many opportunities to help conservation efforts, opportunities which we have hitherto passed by. You will be hearing about these initiatives in the future, both in Carnivorous Plant Newsletter and on the ICPS web site. Members of the ICPS will have an opportunity to pay something back to the plants that have enriched our lives.

Figure 1: Several meeting attendees review the management actions at a *Sarracenia oreophila* seepage bog.

Figure 2: Discussing the effects of woody plant removal at a *Sarracenia oreophila* site.

Figure 3: Small *Sarracenia oreophila* plants persisting despite frequent poaching at a flatwood bog.

Figure 4: *Sarracenia oreophila* plants, mostly dormant, in streamside habitat.

Acknowledgments

I would like to thank all the participants of the *S. oreophila* management meeting for enlightening conversations. I thank the following for their comments on the various drafts of this paper: Ron Determann, Carlen Emanuel, Nora Murdock, Cary Norquist, Este Stifel, David Gray, John Brittnacher, Jan Schlauer, Robert Gibson, and Beth Salvia. A special thanks is due to Carlen Emanuel, for efforts above and beyond.

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International Carnivorous Plant Society Seed Bank

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john@carnivorousplants.org•http://www.carnivorousplants.org

Darlingtonia californica
D. californica— Tillamook Co., Oregon, USA
Dionaea muscipula
Drosera anglica—Oregon, USA
D. auriculata
D. burmannii
D. capensis—narrow leaf
D. capensis—purple flower, narrow leaf
D. capensis—white flower
D. capensis—typical/wide leaf
D. capillaris
D. dielsiana
D. intermedia
D. intermedia—New Jersey, USA
D. intermedia—Rhode Island, USA
D. macrantha subsp. *macrantha*—pink flower
D. rotundifolia—Rhode Island, USA
D. stenopetala
Nepenthes bicalcarata
N. gymnamphora × *?*
N. ventricosa × *?*
Sarracenia alata—Georgia, USA
S. flava—Georgia, USA
S. flava—North Carolina, USA
S. leucophylla—Georgia, USA
S. minor
S. purpurea subsp. *purpurea*—Pennsylvania, USA
S. (flava × *leucophylla)* × *?*
Utricularia multifida
U. violacea

The seed bank is a members-only benefit. A complete, updated list (including other seeds in short supply) is online at the ICPS web site. It is ICPS policy not to distribute seed of plants protected by CITES Appendix I or the US Endangered Species Act.

Seed packets are US$1 each. Please include US$2 postage and handling for each order. Non-USA members may send 2 International Reply Coupons for each packet and 2 IRCs for postage and handling. You may pay by check drawn on a USA Bank in US$. Many members pay for orders with cash. Please make checks and money orders payable to "ICPS Seed Bank".

The quantity of seed available to each member is 1 packet of each variety per month. Larger quantities of selected varieties are available only to teachers for use in the classroom.

The money raised by the seed bank is used by the ICPS to pay for seed bank expenses, web site ISP charges, and ICPS educational and conservation programs. Donate seed and get credit for free seed from the seed bank.

New Observations of Leaf Movements in *Pinguicula* (Lentibulariaceae)

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Introduction

The authors of the most recently published, significant carnivorous plant monograph concluded that "little attention has been paid to the movement in leaves of *Pinguicula* since it was first described and experimentally studied by Darwin (1875)...." (Juniper *et al.*, 1989, p. 108). Darwin's technique was to place prey on the leaf and observe how the leaf rolled upwards and sometimes enclosed the prey. While many aspects of insect trapping in butterworts have been dealt with (Heslop-Harrison, 1970, 1981; Heslop-Harrison & Knox, 1971; Karlsson *et al.*, 1987; Vasilev & Muravnik, 1986; Zamora, 1995; and others), few authors have discussed leaf movement by either using or repeating Darwin's experiments.

The reason for leaf movement in *Pinguicula*, especially the rolling of the leaf margin, is not well understood. The following opinions have been mentioned in the literature:

1)Leaf margin rolling brings more glands into contact with the prey, analogous to the case with *Drosera* (Darwin, 1875).

2)The involute leaf margins help to hold the secretions in place (Lloyd, 1942).

3)Movement brings about a faster digestion; the inflection of the margin over an insect exposes a far greater area of its body to direct contact with the glands. Additionally, the inflection covers and thus protects the prey item from rain (Slack, 1988).

4)The curling movement makes it difficult for kleptoparasitic ants to detect and extract the prey (Zamora, 1990).

None of these authors conclusively defined the principal function of leaf movement in *Pinguicula*. We searched for the answer using a modified version of Darwin's method.

Material and Methods

Leaf movements were documented in *Pinguicula bohemica* Kraj. and *P. grandiflora* Lam. cultivated at the Botanic Garden Liberec. Pieces of meat about 2-4 mm in size were used as the experimental prey and were placed halfway between the leaf margin and the midrib. Pictorial and photographic records of consequent leaf movements were made.

Principal Function of Leaf Movement

Juniper *et al.* (1989) have described carnivorous plants as those that exhibit the "carnivorous syndrome", which they define as having six attributes with respect to prey: 1)Attract, 2)Retain, 3)Trap, 4)Kill, 5)Digest, 6)Absorb useful substances. Since leaf movements in *Pinguicula* play no role in the capabilities 1-4, they must have a

A—at 0 hours, meat is put on a leaf.

B—at 2.5 hours, a capillary tube is formed.

C—at 8 hours, the reaction is maximal, but the piece of food remains outside the tube.

D—at 98 hours, the food has been digested completely and the leaf is rolling back.

Figure 1: Reaction of *P. grandiflora* to food.

function in either digestion or nutrient absorption.

If a large prey item is captured on a butterwort leaf, its consumption is accompanied by movement of a leaf margin in several (but by far not in all) species of the genus. The movement is very slow. Umrath (1944) was the first to measure changes in electric potentials in leaf tissue during these movements. He found it was about 0.1 V for *Pinguicula vulgaris*. These impulses extended a very small distance from a piece of food, and the "action potential" of an excitation impulse was scarcely detectable 6 mm from the spot to which food was applied. Digestion and nutrient absorption might seem to involve only a very small area of a leaf.

In our experiments with *P. grandiflora*, a piece of food was situated a certain distance from the leaf margin (in contrast, Darwin placed prey on either the leaf midrib or margin). The effect of movement was surprising. The leaf-margin rolled lengthwise to form a long tube. The food was not enclosed by this tube, but rather remained just outside it. As such, digestion proceeded without the leaf protecting the prey from other influences. Ultimately the marginal leaf tube lengthened into a very long capillary-like structure, and the area of nutrient absorption was thus maximized (Figure 1).

The response to food by a young *P. bohemica* leaf that was still in a considerably erect position was particularly interesting (see Figure 2). The liquid produced by the leaf, enriched by nutrients from the prey, flowed down the leaf under the influence of gravity. Consequently, parts of the leaf margin far from the piece of food was excited, and in response formed a marginal tube which drew in the liquid by capillary action. The liquid acted as a conductor of excitation in the process, and the marginal tube acted to increase the area of nutrient absorption.

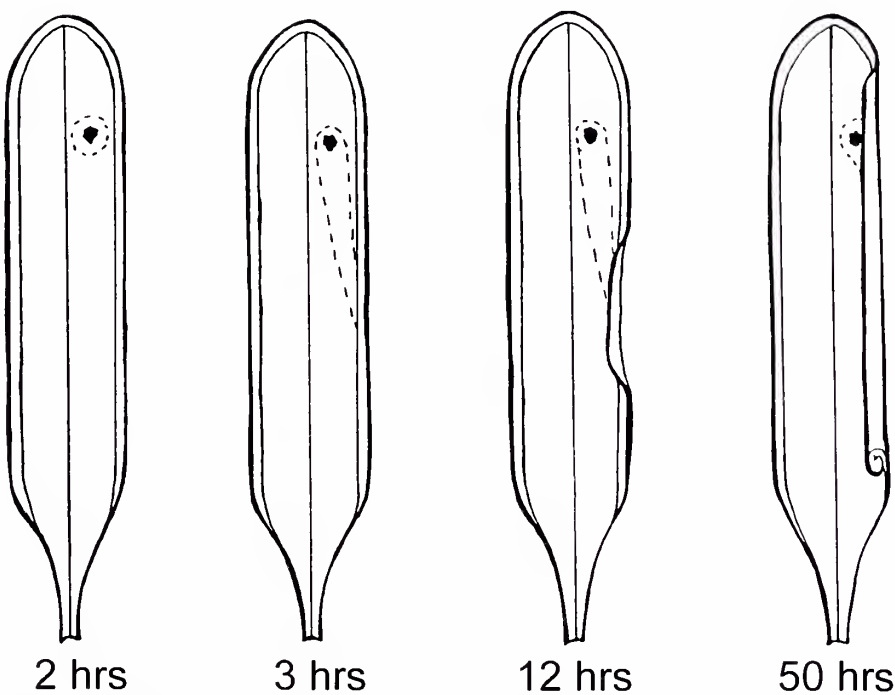

Figure 2: Reaction to food in a young, erect *Pinguicula bohemica* leaf. A—the first secretions are produced. B—the liquid flows towards the lower margin. C—a capillary tube is formed far from the piece of food. D—the tube, aiding the nutrient absorption, is maximally extended while the food is digested alongside it.

It was observed that the slimy liquid product of digestion was dispersed under the influence of gravity. It was also observed that when this liquid flowed into the long tube created by the rolled leaf margin, it was distributed via capillary action over a much larger area of the leaf surface. While Umrath (1944) showed that electrical leaf impulses are responsible for the very local excitation of glands and rolling leaf margin, our observations show that the nutrient-rich liquid itself can be considered a vehicle for long-distance excitation.

From these observations, I can emphasize the sixth attribute of the carnivorous syndrome (absorption of nutrients) as the actual purpose of leaf movements in these species of butterworts. The leaf movement maximizes the absorptive area. While the benefits of leaf movement described in the introduction may be valid, they are not complete without including the effects described in this paper. Butterwort leaf movement aids in nutrient absorption, and not prey digestion.

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Looking Back: CPN 25 years ago

Bill Hanna wrote about an unfortunate perception of *Nepenthes* that he learned about when talking to a botanist from the Singapore Botanic Garden: "In Singapore there are three varieties of *Nepenthes*: *N. ampullaria*, *N. gracilis*, and *N. rafflesiana*. However, it is the official policy of the Ministry of the Environment that they were a potential breeding ground for mosquitos, although she knew of no mosquitos or their larvae in Singapore that were immune to their digestive juices. They enforce this ruling by spraying them thoroughly or physically clearing them completely. But nevertheless, there are still some [persisting *Nepenthes* plants] to be found...."

Otto, C. 1999, Effects of Prey and Turion Size on the Growth and Turion Production of the Carnivorous Bladderwort, *Utricularia vulgaris* L. Arch. Hydrobiol. 145(4): 469-478.

Harms, S. 1999, Prey Selection in Three Species of the Carnivorous Aquatic Plant *Utricularia* (Bladderwort). Arch. Hydrobiol. 146(4): 449-470.

Mendez, M., Gwynn Jones, D. & Manetas, Y. 1999, Enhanced UV-B Radiation Under Field Conditions Increases Anthocyanin and Reduces the Risk of Photoinhibition but does not Affect Growth in the Carnivorous Plant *Pinguicula vulgaris*. New Phytologist 144: 275-282.

Stoyanova, D. 1999, Ultrastructural Responses of Leaf Mesophyll and Trap Wall Cells of *Utricularia vulgaris* to Cadmium. Biologia Plantarum 42(3): 395-400.

The preceding four recent scientific publications on *Utricularia* and *Pinguicula* physiology are too specialized to be discussed in detail here. The titles are quite self-explanatory, and investigators with a serious interest should consult the original papers. (JS)

Owen, T.P., Lennon, K.A., Santo, M.D. & Anderson, A.N. 1999, Pathways for Nutrient Transport in the Pitchers of the Carnivorous Plant *Nepenthes alata*. Annals of Botany 84: 459-466.

Two different tracers have been used to study transport phenomena *Nepenthes alata* pitchers. 1. The heavy metal salt lanthanum nitrate releases lantanum ions in an aqueous solution, which are not taken up by cells. The electron-dense metal ions can be seen as a dark stain in transmission electron microscopy, and it marks extracellular, apoplastic space. Application of this tracer in pitcher fluid did only stain the cell walls (but not the cytoplasma!) of the outer cell layers of digestive glands. It did not enter the leaf further because an endodermoid cell layer (cf. Carniv. Pl. Newslett. 26: 34-38, 1997) serves as a barrier to further apoplastic transport. If applied to vascular bundles of the petiole, lantanum ions were detected in the pitcher and leaf vasculature and in the cell walls of adjacent cells (but again not in the cytoplasma of these cells). No tracer entered the pitcher fluid this way. 2. The fluorescent compound 6-(5)-carboxyfluorescein is taken up actively by cells and is therefore a marker for intracellular, symplastic space. If applied to pitcher fluid, this marker was observed to enter glandular cells and to be transported via a symplastic route to vascular tissue beneath the glands and from there further down the leaf. If fed to petiolar vascular bundles, the fluorescent tracer was able to enter leaves and pitchers up to the mesodermoid layer at the base of digestive glands, but it penetrated the glands and reached the pitcher fluid only in juvenile, unopened pitchers, while it was retained by the mesodermoid layer in ripe, opened pitchers. "This suggest that the endodermal barrier develops more closely to the time of pitcher opening. A more precise study of the development of this endodermal barrier is underway", according to the authors. (JS)

Gervais, C. & Gauthier, R. 1999, Étude cytotaxonomique des espèces et des hybrides naturels du genre *Drosera* (Droseraceae) au Québec. "Cytotaxonomic Study of the Species and Natural Hybrids of the Genus *Drosera* (Droseraceae) in Quebec" (in French, with English abstract). Acta Bot. Gallica 146(4): 387-401.

The literature values for chromosome counts of the *Drosera* taxa growing naturally in Quebec are confirmed. The natural, diploid (2n=20), sterile hybrid *D. linearis* × *D. rotundifolia* is described as *D.* × *woodii*. However, if *D. anglica* is regarded as amphidiploid, fertile offspring of such a hybrid (which is done by most taxonomists), the name *D.* × *woodii* is a later synonym of *D. anglica* (or *D.* × *anglica*, cf. ICBN Art. H.3.4.: "For purposes of homonymy and synonymy the multiplication sign and the prefix "notho-" are disregarded"). The name *D.* × *linglica* (for the hybrid *D. anglica* × *D. linearis*), originally proposed for an artificial hybrid created in cultivation but not properly described as a taxon, is validated by a Latin protologue and the citation of a type specimen. (JS)

Lobreau-Callen, D., Jérémie, J. & Suarez-Cervera, M. 1999, Morphologie et ultrastructure du pollen dans le genre *Utricularia* L. (Lentibulariaceae). "Morphology and Ultrastructure of Pollen in the Genus *Utricularia* L. (Lentibulariaceae)" (in French, with English abstract). Canadian Journal of Botany 77: 744-767.

At least for me (who did originally not read Taylor's monograph thoroughly enough; the essential data were already mentioned but obviously likewise overlooked by him!), this precious piece of literature has been an eye-opener. The essential message is that pollen morphology coincides with other data (not mentioned in this paper), and evolutionary courses become apparent. *Utricularia* can be divided into two natural groups, viz. the species with bracteoles (only *U. heterosepala* apparently never has them but it nevertheless is an unambiguous member of this group), which have pollen with usually 3 to 7 ectoapertures (this includes sects. *Polypompholyx* and *Tridentaria*, which only deviate from sect. *Pleiochasia* in additional calyx lobes, making even subgeneric distinction rather doubtful), and those which persistently lack free bracteoles (the strange fusion product in sect. *Lecticula* possibly marks a "missing" link), which have pollen with 8 or more ectoapertures. As a deviation from the rule, sects. *Psyllosperma* and *Foliosa*, with bracteoles, exhibit the latter pollen type. This is particularly noteworthy because in all representatives of sect. *Foliosa* and in some of sect. *Psyllosperma* the bracteoles are partially fused with their supporting bract, perhaps representing a transitional condition (cf. also sect. *Lecticula*!). Thus, not only plesiomorphic and apomorphic character states but also transitional pathways and possible intermediate conditions become obvious. A more detailed discussion of carnivorous plant evolution (by yours truly) for this journal is in preparation. (JS)

Blanca, G., Ruíz-Rejón, M. & Zamora, R. 1999, Taxonomic Revision of the Genus *Pinguicula* L. in the Iberian Peninsula. Folia Geobotanica 34: 337-361.

An interesting review of available data from recent collections and literature. Apparently (if the plants were identified correctly), *P. vulgaris* co-occurs with what the authors identify with *P. mundi* in the Tajo gorge (Cuenca, Spain). This requires confirmation, because the plants known from there resemble neither taxon but rather *P. longifolia* subsp. *dertosensis* (called *P. dertosensis* in the present paper), which is also geographically the closest taxon. Noteworthy is the occurrence of *P. grandiflora* in southern Spain (not hitherto recorded from here), which could explain (in terms of a "bridgehead" position) herbarium specimens that were allegedly collected in Morocco (part of the confused mixed material with *P. vulgaris*, on which the ambiguous name *P. fontiqueriana* was based; cf. Ann.Bot.Fennici 33:31, 1996). A still more recent update for *P. lusitanica* is in: Sánchez-Rodríguez, J.A. 2000, *Pinguicula lusitanica* L. (Lentibulariaceae), novedad para el Sistema Central. Anales Jardín Botánico de Madrid 58(1): 196-197. (JS)

Marj Boyer (marj.boyer@ncmail.net), botanist from the North Carolina Plant Conservation Program, writes: The good news is that carnivorous plants, private landowners, the government and non-profit conservation groups can all win sometimes. In November 2000, we celebrated the establishment of a new preserve in southeastern North Carolina that is rife with Venus flytraps, a lot of other carnivorous plants, and a long list of rare species including the federally-listed roughleaf loosestrife (*Lysimachia asperulifolia*) and red-cockaded woodpecker (*Picoides borealis*). The preserve, which will eventually total about 2200 ha (5400 acres), came about thus:
—The private landowner freely offered it for sale.
—The Nature Conservancy (TNC) wanted to buy it but did not have the funds ready.
—The government (the State of North Carolina, via the Plant Conservation Program (PCP) in the state Department of Agriculture) could get the money through the state Heritage Trust Fund which is funded by the sale of vanity license plates (i.e. nobody was forced to pay taxes for the fund).
—TNC and PCP made an agreement: the State will hold title to the land as a dedicated nature preserve in perpetuity, while TNC will manage the preserve.

TNC is happy, the State is happy, the seller is happy, the local town is happy (they are getting a little piece of the land for a community center as part of the deal), and the Venus flytraps, *Drosera*, *Pinguicula*, *Sarracenia*, and *Utricularia* that grow there should live happily ever after. In order to preserve the delicate habitat, public visitation is not planned for this site.

Michael Catalani (506 Country Way, Cordova TN 38018, mcatalani@aol.com) sent us the following report: Recently my girlfriend and I went to Gulf Shores, Alabama, for a vacation of beach and carnivorous plant hunting. We went to three of my favorite south Alabama and Mississippi bogs that contained *S. alata* and *S. leucophylla*. I saw more evidence of recent poaching in this trip than in my past twelve years of visiting the area combined! None of the Alabama nor the Mississippi locations appear to be under an imminent danger of habitat destruction. In fact, the south Alabama site has remained unchanged for the past twelve years. The biggest imminent danger that the pitcher plants in these bogs face are people who sport a shovel and lack any form of self control. Every time I take a trip down to the gulf, I get more and more infuriated with what I see happening.

At the first (Alabama) site, we found massive evidence of very recent poaching. The site was invaluable to me in the study of *Sarracenia* hybridizing in the wild, as well as studying the different cultivating requirements of the two pitcher plants. The *S. leucophylla* restricted itself to the stream bed and the deepest parts of the bog, whereas *S. alata* grew up in the drier parts. The two species hybridized madly in the bog, and the hybrids more or less restricted themselves to the intermediate zones between the parents. While at its wettest, the bog contained about 20% *S. leucophylla*, 20% *S. alata*, and 60% hybrids with a total estimated pitcher plant population of 8,700 plants. I had also found some *S. alata* with a few very faint areoles, the type of plants which have been mentioned in Carnivorous Plant Newsletter as being found in Texas or Louisiana.

My legs still hurt from stepping in the numerous 15-20 cm (6-8 inch) potholes formed when the poachers dug the plants up. I could see *Sarracenia* roots sticking up out of these holes. The trail they made through the bog and the shovel markings lead me to believe that the most recent poaching occurred no more than seven days before my visit. It looks like the poachers were going after the pure specimens of *S. alata* and *S. leucophylla*—the plants they left behind were hybrids. The poachers probably ended up with plants that they believe are true species, but are in fact complex hybrids. The poachers will no doubt pass these plants into the market as species material.

The second site is a bog area immediately across the highway from the first site. Only *S. alata* grew here—very large *S. alata*. Four years ago I measured a pitcher that was 1.2 m (48 inches) tall, and most of the plants were in the 60-90 cm (24-36 inches) tall range. Nearly 100% of the plants had been removed.

The third spot was near Moss Point, Mississippi. It was a one acre site that had dozens of pure *S. alata* plants; some that produced bizarre color variants. Of particular interest was one *S. alata* plant that produced bright (almost neon) banana yellow pitchers, several plants that produced blood red pitchers with no veining, and a few plants that produced deep black cherry pitchers with typical veining. 100% of them had been removed. While this bog is in an area that may see development in the near future, I saw no immediate threat to the plants.

(Editor's note: the ICPS has contacted law enforcement agencies, conservation agencies, and native plant societies in Alabama and Mississippi regarding these incidents. Anyone with information regarding this theft should contact the ICPS.)

Rich Ellis (1276 Cavan St., Boulder CO 80303 USA, ricell@juno.com) writes: This past year has been a good year for anyone interested in carnivorous plant stamps. Malaysia issued a series of stamps celebrating the new millennium that included a stamp portraying an upper pitcher of *Nepenthes lowii*. Slovenia issued a stamp for World Environment Day commemorating wetland flora and fauna that includes a close-up of a leaf of *Drosera anglica*. Brunei issued a series of stamps on native plants that includes a stamp with three *Nepenthes rafflesiana* upper pitchers. Finally, the USA released four carnivorous plant stamps, as previously reported in News and Views.

Susan Farrington (Missouri Botanical Garden, P.O. Box 299, St. Louis MO 63166-0299 USA, susan.farrington@mobot.org) researched a strange story many of us have seen reported in the media: A new urban legend of sorts was born this past year, concerning the discovery of a "new" *Utricularia* species growing "completely underground." The story originated from a UPI press release that derived from a local newspaper story in Florida. As so often happens, the facts were distorted by the media, which especially sensationalized the "meat-eating" characteristics of the plant. Calls from around the world flooded the Archbold Biological Station in Lake Placid, Florida where the discovery was made.

In fact, the *Utricularia* "discovered" is not a new species, but is most likely *Utricularia subulata*, a species common throughout the eastern United States. What was unusual about this "discovery" was not the plant itself, but the particular conditions in which it was growing. Two botanists from the University of Florida that specialize in plant physiological ecology (Kevin P. Hogan and Stephen Mulkey) made the discovery. In a message Hogan sent me, he wrote, "At Archbold we found it growing around the edges of ponds that had probably been larger but were becoming smaller as the dry season progressed. It seemed to be most common in areas of clean white sand around but not in ponds, and not on other types of soil. In some areas it was very abundant, and when we scraped away the sand at the surface, we found a dense and extensive network of underground 'stems' and 'leaves.' This mode of life would only be possible under these special conditions. We do not yet know whether it is a genetic variant especially adapted to these conditions, or whether it is simply taking advantage of an opportunity. The light it receives there is enough for photosynthesis. By living underground it may be protected from drying out and from too much sun, and the availability of carbon dioxide might be higher, which would increase photosynthesis In this sand there is also an alga that forms a slightly greenish layer at a depth of approximately 2 cm, about the same depth at which the *Utricularia* networks were found."

Hogan and Mulkey certainly had not intended to publish their findings via press conference, and had attempted to correct errors in the original draft of the local newspaper story.

Manny Herrera (11945 S.W. 10th Ter., Miami FL 33184 USA, mannyfire@yahoo.com) sent in some beautiful photographs of *Sarracenia*, with the following commentary: It is always pleasant and exciting to read about carnivorous plants in far-away lands. Descriptions of habitats and photographs of different genera in their native lands fascinate me. Articles covering the "giant" *Drosera* of South Africa always captivate me. I love to read of the discovery of new species from the *D. petiolaris* complex in Western Australia. Finally, the explorations of the extraterrestrial tepuis or of the forbidden jungles of southeast Asia are without a doubt an escape from reality for me.

Several years ago I read an article in Carnivorous Plant Newsletter written by an Australian. He mentioned that he felt Australians were fortunate to live in a virtual carnivorous plant paradise. While fellow carnivorous plant enthusiasts in the land down under may see themselves as blessed (they can barely walk out of their homes without trampling on a sundew!), I believe it is us southerners of the USA that have truly been endowed with a gift from on high. For we live in the realm of the almighty *Sarracenia*.

I will not demote the sight of an montane forest sprawling with *Nepenthes*, nor a misty plateau covered with *Heliamphora*, but I will venture to say that none compare with the explosion of color visible in a savanna graced with *Sarracenia*. I have travelled from the Atlantic coastal bogs of North Carolina to the envied prairies of the gulf coast. Wherever they are found in pristine locations, *Sarracenia* dominate the landscape, towering over the vegetation, robed in splendid veining and crowned with compelling lids.

I will not leave you with mere words. Bob McMorris and I recently trampled through bogs from the Florida panhandle to southern Alabama and Mississippi. We found several breathtaking sights, especially the seepage bogs of Mississippi, at all our destinations. Here are photos of some of what we saw (Figure 1). Please remember that there is only so much photography can capture. To feel the same emotion I did, one must undertake a pilgrimage to the southlands and pay homage to these botanical deities!

Figure 1: From left to right, *S. flava*, Florida; *S. flava*, Florida; *S. flava*, Florida; *S. leucophylla*, Alabama; *S. alata*, Mississippi.

Barry Meyers-Rice (P.O. Box 72741, Davis CA 95617 USA, barry@carnivorousplants.org) writes: In a recent conversation with Ron Determann, from Atlanta Botanical Gardens, I learned that a native population of *Sarracenia leucophylla* has been discovered in Georgia. This is a new record for Georgia. It is not known whether this represents a population of plants that has long been disjunct from the more eastern populations of *Sarracenia leucophylla*, or intervening populations of plants have just been destroyed by human development. In any event, Ron said that Atlanta Botanical Gardens and the Georgia Department of Natural Resources are working on

protecting this plant. The site is privately owned and is not available for visitation.

Marc Verdyck (Vorselaarsebaan 4, B-2280 Grobbendonk, Belgium, marc.v@drosera.org) writes: The Second edition of the European Carnivorous Plant Exchange and Exhibition will take place on Saturday, September 8, 2001 in the Botanical Garden of the University of Ghent, Belgium. All people interested in carnivorous plants are invited to come. Our goal is to organize a large carnivorous plant exchange, sale and an exhibition of plants and plant compositions. Everyone is invited to participate, ranging from members with spare plants from their own collection up to the big nursery. We hope to offer as many plants and plant varieties as possible, due to your contribution! In the afternoon there will be several interesting slide shows about carnivorous plant. The organizers expect that the rules of CITES will be regarded. In particular it is forbidden to offer plants taken directly from nature! We hope that the European Carnivorous Plant Exchange and Exhibition will take place every year, changing from country to country. The first edition at the Botanical garden of the University in Bonn was a great success! Whether this edition will be as successful as the first will depend on your visit and/or participation! We would be very happy to meet you in Ghent! (Information, including schedules, will be placed on the ICPS web site as this information becomes available—ed.)

New Back Issue Pricing

Back issues are now $20 per volume, plus postage & handling. Postage & handling for orders of 1 to 5 volumes is $7.00 for USA, $10.00 for Canada and Mexico, $15 International. Double the postage & handling charges for 6 to 10 volumes, triple it for 11 to 15 volumes, etc. California residents must add $1.60 sales tax per volume. The price is expected to increase to $25 per volume January 2002.

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The ICPS is clearing out all CPN back issues more than 5 years old. All available printed issues of Volumes 7-24 (1978-1995) are at a special price of $125.00 plus shipping and handling. Issues 1987 #2, 1988 #3, and 1989 #3 are no longer available. Other issues are in short supply, so do not delay. If, when your order arrives, more than six additional issues are unavailable we will provide partial refunds. Check the ICPS web site and future issues of CPN for updates on back issue sales.

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How To Build A Personal Reverse Osmosis Waterworks

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Keywords: cultivation: water.

Introduction

Without pure water carnivorous plants slowly die. This is because their root systems—not used to mineral-rich water—wither away. Since I mist my orchids daily, water them on the weekend, and top off my carnivorous plant trays as necessary, I use about 95 liters (25 gallons) of water per week. There are different ways to get pure water for your plants. You can buy it from the store, have it delivered, or process tapwater in your home by distillation or Reverse Osmosis (RO). For my rate of water consumption, it made sense to construct a home system.

Distillation is the only way to get 100% pure water, but a good quality RO system with pre-filters gets pretty close (certainly close enough for carnivorous plant cultivation!). Distillers have drawbacks and advantages. A distiller requires gas or electricity to boil and then cool its water. Furthermore, the solutes (dissolved solids) cake the inside of the boiling chamber and must be cleaned out periodically. On the other hand, it wastes very little water.

RO systems also have their bad and good sides. A typical RO system can waste up to 3/4 of the water put through it, dumping it overboard, and occasionally needs to have its filters replaced. On the beneficial side, they operate solely on tap water pressure, and needs no gas or electrical power. They are also less expensive. I decided to purchase an RO system, instead of a distiller, when I found one on sale for only US$169. It came with three pre-filters (one sediment and two carbon), a 68 liter/day (18 gallon/day) RO membrane, an eleven-liter (three-gallon) pressurized storage tank, a carbon post-filter, and a spigot. This unit takes about 2-1/4 hours to fill the storage tank.

RO System Components

Osmosis is the tendency for water to cross a selectively permeable membrane, exiting a less concentrated solution of impurities and entering a more concentrated solution. In Reverse Osmosis filtration this flow direction is reversed. Water is forced under pressure towards the membrane. The small water molecules pass through the membrane to a lower pressure zone. The larger impurity molecules cannot pass through the membrane. The pressure on the output side of the membrane is much less than the pressure on the input side. (If you already have a home RO system for drinking water, you know the flow is much less than from the regular tap.)

The water purified by the system is routed into one of two types of storage tanks—either a pressurized storage tank or an unpressurized (also known as "atmospheric") storage tank. A pressurized storage tank holds the water in a balloon-like sack inside a metal tank which has been pre-pressurized with compressed air. When you turn on the tap, the balloon (which is being squeezed by the com-

pressed air trapped in the tank with it) expels its contents through the tap. To send water from an atmospheric storage tank to a tap, you need a kind of "booster pump" called a "demand pump." Only the most expensive demand pumps approach the water delivery rate you get from a normal household tap.

While convenient, pressurized storage tanks can be wasteful of water. This is because as you get closer to filling the tank its pressure rises. As a result, fewer and fewer molecules will cross the RO membrane, and instead are expelled as wastewater. This increases the amount of water wasted. It is better if you can dump the water purified by the RO system into an atmospheric tank. You could use the wastewater on plants that are insensitive to (or thrive on) concentrated minerals. A good RO system should shut off automatically when the storage tank is full to minimize wasting water.

RO systems are equipped with prefilters: charcoal for chlorine, and mechanical for bacteria. The RO membrane can be damaged by chlorine, so this filter must not be removed if your water is chlorinated. Since these filters are not perfect, there will always be some bacteria in the water purified by the system. Without chlorine present, the bacteria can explode in population, especially in an unsealed, easily contaminated atmospheric tank. As a result, water in atmospheric tanks may not be suitable for drinking. To deal with this issue, some expensive RO systems run the purified water through an ultraviolet sterilizer.

A Custom-Built RO System

I built a system that dumps the output of the RO system into a 150 liter (40 gallon) atmospheric tank then uses an inexpensive, low-flow booster pump to move it into a 140 liter (36 gallon) pressurized tank.

Tapwater purified by the RO system is deposited into an atmospheric storage tank. Wastewater from the RO system exits into a second atmospheric storage tank where it is used to water plants which are not bothered by mineralized water. The pump draws RO water from the atmospheric storage tank and pumps it into the pressure tank.

As water is drawn from the pressure tank, the booster pump turns on to replenish it from the atmospheric tank. Because the flow rate of the booster pump is very low, only the volume of water in the pressure tank can be used before waiting for the tank to recharge. You must size the pressure tank larger than the volume of water you intend to use at one time and the atmospheric tank should be larger than this so that the pump does not run dry. Note that a pressurized tank holds about one third water and two thirds air; thus a 140-liter pressurized tank holds less than 57 liters of water.

If you would like to see detailed building instructions on how to construct a home RO system, as I did, contact me.

Some other useful web sites are:

http://www.softwater.com/faq.html (Water quality and purification systems)

http://www.premierh2o.com/ (RO Systems)

http://rosystems.com/ (RO Systems)

http://www.wellmate.com/catalog/eseries.html (Pressure Tanks)

(Editor's Note: The casual plant grower may also consider renting an RO unit. High quality units can be rented inexpensively, and as Ron describes in his article, the output can be directed into pressurized or atmospheric tank—BAMR)

Figure 1: *Nepenthes inermis*, by Andreas Wistuba.

Figure 2: *Nepenthes tomoriana*, by Andreas Wistuba.

Figure 3: *Nepenthes eymae*, by Andreas Wistuba.

Figure 4: *Nepenthes dubia*, by Andreas Wistuba.